Optical Field Reconstruction using Phase-Space Tomography

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(1). Manuscripts submitted or published under ARO sponsorship during this period:

1. "Optical phase retrieval by phase-space tomography and fractional-order Fourier transforms," D. McAlister, M. Beck, L. Clarke, A. Mayer and M. G. Raymer, Opt. Lett. 20, 1181 (1995).

2. "Propagation of Wigner coherence functions in multiple scattering media," M. G. Raymer, C. C. Cheng, D. M. Toloudis, M. Anderson, and M. Beck, in Advances in Optical Imaging and Photon Migration, 1996 Technical Digest (Optical Society of America, Washington, DC, 1996), pp. 236-238.

3. "Measurement of the propagation of the Wigner generalized radiance function in a multiple scattering medium," M. G. Raymer, C. Cheng, A.C. Funk, H. Heier, in OSA Annual Meeting: Focus on the Life Sciences (OSA Proceedings, 1997). pg/114.

(2). Supported Personnel and Degrees:

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(3). Inventions: (none)

(4). Statement of Problem Studied and Main Results Obtained

Measurement of light transport in a random, multiple-scattering medium can provide details about the spatial structure of inhomogeneities within the medium. A precursor to this is the understanding of optical wave transport in a homogeneous, random dielectric medium. The goal is to measure the two-point optical field correlation function for continuous-wave laser light after propagating through a random-dielectric medium. This can be related to the Wigner function (WF), which is a quasi-distribution function representing the generalized radiance of the light. The WF contains both wave and ray-like transport behavior. A theoretical model should be developed that is capable of describing and predicting such optical transport.

Progress made includes construction of a new system for making measurements of the complex, two-point optical field correlation function for continuous-wave laser light after propagating through a random-dielectric medium, in particular polystyrene spheres in water. The new system is based on a Sagnac shearing interferometer, with a CCD camera and computer processor. Several important design issues, dealing with resolution and throughput were solved by use of optical design software.

The system was used in preliminary measurements of a variety of medium thicknesses and scatterer concentrations. Progress was made is developing a model for the transport. In certain cases good agreement between experiment and theory was found, but further work was called for. We were successful in observing and modeling the transition from wave-like (coherent) to particle-like (incoherent) transport.

This result provides a solid base for the next phase of the project, which is continuing into 1999 under a new grant.

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13. ABSTRACT *(Maximum 200 words)*

Measurement of light transport in a random, multiple scattering medium can provide details about the spatial structure of inhomogeneities within the medium.

Progress made includes construction of a new system for making measurements of the complex, two-point optical field correlation function for continuous-wave laser light after propagating through a random-dielectric medium, in particular polystyrene spheres in water. The new system is based on a Sagnac shearing interferometer, with a CCD camera and computer processor. Several important design issues, dealing with resolution and throughput were solved by use of optical design software. Quantitative agreement has been found between measurements and theory, providing new insights into the behavior of light as it travels in random media.

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